

Appl. No. 10/766,231

Amdt. Dated December 27, 2006

Reply to Office Action of October 18, 2006

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AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the above-identified application:

1. (currently amended): A turbine blade for a gas turbine engine, comprising:  
an airfoil having at least an outer surface, a bottom edge, and a top edge;  
a plurality of internal cooling channels formed in the airfoil; and  
a plurality of film cooling holes extending through the airfoil and in fluid communication with one of the internal cooling channels, the plurality of film cooling holes arranged into at least two adjacent rows, each row disposed on at least a portion of a line that extends between the airfoil top and bottom edges, and each film cooling hole having an inlet port, an outlet port, and a centerline extending therethrough,

wherein:

- (i) the centerline of each film cooling hole forms a compound angle with respect to a tangent of the airfoil outer surface,
- (ii) a distance between the centerlines of each film cooling hole is at least a predetermined minimum distance,
- (iii) the compound angle of each film cooling hole centerline comprises at least a first angle formed with respect to a first predetermined datum structure and a second angle formed with respect to a second predetermined datum structure, and
- (iv) the outlet port of each film cooling hole is located ~~a first predetermined distance from~~ at a position relative to the first datum structure and ~~a second predetermined distance from~~ the second datum structure,
- (v) the position of each film cooling hole relative to the first datum structure is determined by (1) rotating a first locator plane, about a first reference axis that is perpendicular to the first datum structure, a predetermined number of degrees relative to the first datum plane and (2) translating the first locator plane a first predetermined distance in a predetermined direction that is perpendicular to the first locator plane, and

Appl. No. 10/766,231

Amdt. Dated December 27, 2006

Reply to Office Action of October 18, 2006

(vi) the position of each film cooling hole relative to the second datum structure is determined by (1) rotating a second locator plane, about a second reference axis that is perpendicular to the second datum structure, a predetermined number of degrees relative to the second datum plane and (2) translating the second locator plane a second predetermined distance in a predetermined direction that is perpendicular to the second locator plane.

2. (original): The turbine blade of Claim 1, wherein each film cooling hole in each row is offset from each of the film cooling holes in the adjacent row.

3. (canceled).

4. (canceled).

5. (previously presented): The turbine blade of Claim 1, wherein the first and second predetermined datum structures are first and second datum planes, respectively.

6. (original): The turbine blade of Claim 5, wherein the first and second datum planes are disposed perpendicular to one another.

7. (currently amended): The turbine blade of Claim 1, further comprising: a mounting section coupled to the airfoil bottom edge and adapted to couple to a turbine wheel, the mounting section including one or more cooling channel inlet ports in fluid communication with one or more of the internal coolant cooling channels.

8. (original): The turbine blade of Claim 1, wherein the centerline of each film cooling hole forms an angle with respect to a tangent to the airfoil outer surface that is between about 15-degrees and about 30-degrees.

Appl. No. 10/766,231

Amdt. Dated December 27, 2006

Reply to Office Action of October 18, 2006

9. (original): The turbine blade of Claim 8, wherein the angle is less than about 20-degrees.

10. (original): The turbine blade of Claim 1, wherein the predetermined minimum distance is between about two and about four times a hole diameter.

11. (previously presented): A method of forming a plurality of film cooling holes in a turbine airfoil having an outer surface and a plurality of internal cooling channels, the method comprising the steps of:

defining at least a first datum structure and a second datum structure;  
forming each of the plurality of film cooling holes through the airfoil, and into fluid communication with one of the internal cooling channels, at a location on the airfoil outer surface relative to the first and second datum structures, each film cooling hole having a centerline extending therethrough that forms a compound angle with respect to a tangent of the airfoil outer surface,

wherein:

the first and second datum structures are first and second datum planes, respectively,

each film cooling hole is located at a position relative to the first and second datum planes,

the position of each film cooling hole relative to the first datum plane is determined by:

rotating a first locator plane, about a first reference axis that is perpendicular to the first datum plane, a predetermined number of degrees relative to the first datum plane, and

translating the first locator plane a first predetermined distance in a predetermined direction that is perpendicular to the first locator plane,

and

the position of each film cooling hole relative to the second datum plane is determined by:

Appl. No. 10/766,231

Amdt. Dated December 27, 2006

Reply to Office Action of October 18, 2006

rotating a second locator plane, about a second reference axis that is perpendicular to the second datum plane, a predetermined number of degrees relative to the second datum plane, and  
style="padding-left: 40px;">translating the second locator plane a second predetermined distance in a predetermined direction that is perpendicular to the second locator plane.

12. (original): The method of Claim 11, wherein the compound angle of each film cooling hole centerline comprises at least (i) a first angle formed with respect to the first datum structure and (ii) a second angle formed with respect to the second datum structure.

13. (canceled).

14. (canceled).

15. (previously presented): The method of Claim 11, wherein the position of each film cooling hole on the airfoil is at a location where the first and second locator planes intersect the airfoil outer surface after each has been translated the first and second predetermined distances, respectively.

16. (currently amended): A gas turbine engine, comprising:

~~a compressor having an inlet and an outlet and operable to supply compressed air;~~  
~~— a combustor coupled to receive at least a portion of the compressed air from the compressor outlet and operable to supply combusted air; and~~

~~— a turbine having a plurality of turbine blades coupled to and extending radially therefrom, the turbine coupled to receive the combusted air from the a combustor and at least a portion of the compressed air from the a compressor, each of the turbine blades including:~~

an airfoil having at least an outer surface, a bottom edge, and a top edge,

Appl. No. 10/766,231

Amdt. Dated December 27, 2006

Reply to Office Action of October 18, 2006

a plurality of internal cooling channels formed in the airfoil, and  
a plurality of film cooling holes extending through the airfoil and in fluid communication with one of the internal cooling channels, the plurality of film cooling holes arranged into at least two adjacent rows, each row disposed on at least a portion of a line that extends between the airfoil top and bottom edges, and each film cooling hole having an inlet port, an outlet port, and a centerline extending therethrough,

wherein:

- (i) the centerline of each film cooling hole forms a compound angle with respect to a tangent of the airfoil outer surface,
- (ii) a distance between the centerlines of each film cooling hole is at least a predetermined minimum distance,
- (iii) the compound angle of each film cooling hole centerline comprises at least a first angle formed with respect to a first predetermined datum structure and a second angle formed with respect to a second predetermined datum structure, and
- (iv) the outlet port of each film cooling hole is located a first predetermined distance from at a position relative to the first datum structure and a second predetermined distance from the second datum structure,
- (v) the position of each film cooling hole relative to the first datum structure is determined by (1) rotating a first locator plane, about a first reference axis that is perpendicular to the first datum structure, a predetermined number of degrees relative to the first datum plane and (2) translating the first locator plane a first predetermined distance in a predetermined direction that is perpendicular to the first locator plane, and
- (vi) the position of each film cooling hole relative to the second datum structure is determined by (1) rotating a second locator plane, about a second reference axis that is perpendicular to the second datum structure, a predetermined number of degrees relative to the second datum plane and

Appl. No. 10/766,231

Amdt. Dated December 27, 2006

Reply to Office Action of October 18, 2006

(2) translating the second locator plane a second predetermined distance in a predetermined direction that is perpendicular to the second locator plane..

17. (original): The gas turbine engine of Claim 16, wherein each film cooling hole in each row is offset from each of the film cooling holes in the adjacent row.

18. (canceled).

19. (canceled).

20. (previously presented): The gas turbine engine of Claim 16, wherein the first and second predetermined datum structures are first and second datum planes, respectively.

21. (original): The gas turbine engine of Claim 20, wherein the first and second datum planes are disposed perpendicular to one another.

22. (currently amended): The gas turbine engine of Claim 16, further comprising: a mounting section coupled to the airfoil bottom edge, the mounting section adapted to couple to a turbine wheel and including one or more cooling channel inlet ports in fluid communication with one or more of the internal ~~coolant~~ cooling channels.

23. (original): The gas turbine engine of Claim 16, wherein the centerline of each film cooling hole forms an angle with respect to a tangent to the airfoil outer surface that is between about 15-degrees and about 30-degrees

24. (original): The gas turbine engine of Claim 23, wherein the angle is less than about 20-degrees.

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No. 6034 P. 11/14

Appl. No. 10/766,231

Amtd. Dated December 27, 2006

Reply to Office Action of October 18, 2006

25. (original): The gas turbine engine of Claim 16, wherein the predetermined minimum distance is between about two and about four times a hole diameter.